

CERTIFICATE OF MAILING UNDER 37 CFR§ 1.10

I hereby certify that this correspondence is being deposited with the United States Postal Service as Express Mail in an envelope addressed to: Assistant Commissioner of Patents, Washington, DC 20231 on December 3, 2001

EXPRESS MAIL LABEL: **EL 8885500015 US**

Amirah Scarborough
Name of Person Mailing Document

Amirah Scarborough
Signature of Person Mailing Document

**METHOD AND SYSTEM OF DYNAMIC VIDEO DRIVER
SELECTION ON A BOOTABLE CD****BACKGROUND OF THE INVENTION****1. Technical Field:**

The present invention relates generally to data processing systems and in particular to video drivers of data processing systems. Still more particularly, the present invention relates to a method, system, and computer program product for dynamically selecting specific video driver resources from a read only bootable medium to support a particular video adapter/card of a data processing system.

2. Description of the Related Art:

Data processing systems require hardware and software components to operate. In addition to the basic hardware components, such as the processor and memory, and software components, such as the operating system (OS), typical systems include a visual output mechanism that enables the user to view the applications and processes being run by the processor. Additionally, in order for the data processing system to begin operating, it must complete a boot up procedure by which the various hardware and software components are initialized for operation. For example, during a standard boot procedure, the boot program detects the memory capacity, the processor speed, and the type (or configuration) of Input/Output (I/O) devices, such as a mouse, keyboard and monitor.

Following the detection of these components, various component drivers (i.e., configuration files, etc.) are loaded into the system memory to enable the components to operate correctly. The drivers are computer programs that allow a specific hardware component to communicate with the OS or operating environment of the computer system. For example, a mouse driver is loaded into memory, corresponding to the specific mouse type detected. Also, a video driver is loaded corresponding to the operating characteristics of the video adapter/card detected. These operating characteristics are activated by the video capabilities supported by the OS and made available with the video driver (configuration files, etc.) loaded during boot up.

There presently exists many different types of OS, as well as many different types of display devices/video adapters and corresponding device drivers. Typically, each video adapter requires a unique set of configuration parameters (e.g., color counts and image resolution) and a unique video driver to operate properly. Thus, in most data processing systems, specific adapters are often provided and a corresponding device driver is required to support each hardware component that is connected to the system. With data processing systems utilized as server systems, for example, ServeRAID adapters are typically utilized. These server systems may range from the PC Server family of servers to the more current EServer family. Often, in servers that support these ServeRAID adapters, there is no OS installed on the hard drive and thus, a tool is needed to configure and maintain the ServeRAID adapters during the boot process and beyond. This tool is also required whenever a critical hard drive failure renders the operating system inoperable.

Thus, the ServeRAID configured systems provides an application called the ServeRAID Manager, which has a GUI interface that allows a user to interact with the ServeRAID adapters. The ServeRAID Manager is launched using a bootable CD running the Linux OS. This allows the user to configure the ServeRAID adapters before an

operating system is installed on the hard drives or when a hard drive failure renders the operating system unusable.

The Linux OS comprises a graphical user interface (GUI), an X-Window System, and other components. The X-Window system is an open, cross platform, client/server system for managing a windowed graphical user interface in a distributed network.

Normally, when setting up a Linux installation, it is required for the user to choose an XServer that is compatible with the video adapter in the system. For example, if a user is installing X-Windows on a server that contains a S3 Incorporated S3Trio64V+ video adapter, the user should configure the XF86_S3 Server since this is the server which works with this video adapter.

Linux makes use of symbolic links which are similar to shortcuts used in the Windows OS of Microsoft Corp. A symlink (symbolic link) is not a useful file by itself but points to another file, which is accessed when the symlink is accessed. Thus, when X-Windows starts, it searches for the file "/etc/X11/X". This file "points" to the XServer chosen by the user. X-Windows will load the server that /etc/X11/X points to and, therefore, it is important that /etc/X11/X points to the correct XServer. So, for the example above, the user would make /etc/X11/X point to /usr/X11R6/bin/XF86_S3 in order to load the XF86_S3 XServer when X-Windows starts.

The Linux-based boot CD must be able to run on many different servers which are configured using a range of different hardware devices. One such device which differs from server to server is the video adapter/card, which requires a specific video driver to display graphical representations. Many older servers use antiquated video devices, which do not work well with modern software, while newer servers use video adapters with all the latest features and which work well with today's software. The

Linux bootable CD must work with all of these video adapters in order to properly boot the system and display the ServeRAID Manager GUI interface to the user. That is, the boot CD should be able to switch video drivers on the fly if the correct driver operation is desired.

However, the Linux boot CD is a read only CD, (i.e., it cannot be written to once manufactured). Thus, it is not possible to change /etc/X11/X symlink once the data has been burned into the CD and this prevents the applicable video driver from being properly selected during the boot process. When booting from a read only Linux CD, the symlink file can only point to a single generic driver or to a driver which may not work for a different video adapter on a different or the same server. Because the symlink file may only point to a single file and the boot CD cannot be written to, current boot CDs provide one generic video driver that is utilized to support the various different servers and video adapters found in the servers. In order to maintain compatibility with older video drivers, the generic driver may run with only 16 colors and VGA resolution (e.g., 640 x 480). However, with current systems, video adapters and monitors are well suited to display higher color counts and higher resolution in order to present a crisp user interface and a large desktop. A need exists for a way to provide hardware specific drivers and configuration utilities to maximize the display capabilities of each display device that may be encountered.

Previous approaches have attempted to provide hardware specific and/or dynamic driver selection. For example, U.S. Patent No. 5,325,532 describes a way to generate a boot image based on current system configuration by retrieving device drivers from read only memory of the computer system (i.e., not a Linux boot CD ROM). Additionally, U.S. Patent No. 5,325,532 describes a way to select and load a video driver based on current video system configuration by utilizing an intermediate video driver and a pass-

through mechanism. However, neither of these approaches solves the inherent problem with a Linux read only boot CD or similar boot medium.

The present invention thus recognizes that it would be desirable to enable dynamic selection of an XServer and corresponding configuration files for a video adapter of a data processing system during boot up from a read only boot medium. A read only boot medium for a data processing system that is capable of providing specific, selectable video resources for the video adapter present in the data processing system would be a welcomed improvement. It would be further desirable to provide a method, system and program product by which a symlink file on a read only bootable medium is able to affect the dynamic selection of a particular XServer from a plurality of XServers on the read only boot medium. These and other benefits are provided by the invention described herein.

SUMMARY OF THE INVENTION

Disclosed is a method, system, and program product for enabling selection of appropriate, available resources for a hardware component of a data processing system during system boot via a read only medium. The method comprises various steps including first initiating a boot process from the read only medium on the data processing system. The type of hardware component is detected and then a copy of the symlink file is made on to the RAM of the data processing system. The object of a symlink file located on RAM is dynamically set to reflect the particular resource required for optimal operation of the detected hardware component. Thus, the symlink file located on the read only medium points to and triggers the activation of the symlink file on RAM. The first symlink file on RAM points to and selects the particular resource set as its object from among multiple available resources located on the read only medium. The selected resource is utilized to support the hardware component during operation of the data processing system.

One embodiment enables the dynamic selection of an XServer corresponding to a system video adapter during boot up of the system via a read only boot CD. The boot CD provides a list of selectable XServers to cover each possible adapter type. During the boot process, the boot code determines which video adapter is present in the system. A symlink file on the boot CD is made to point to a secondary symlink file on the RAM of the system during manufacturing. The second symlink file is created during the initial boot process and is dynamically modified to point to a correct XServer following the detection of the type of video adapter present. The second symlink file then points to the correct XServer and initializes that XServer on the boot CD.

In another embodiment, the boot CD also comprises a configuration type symlink file that points to a configuration file of the video adapter. According to this

embodiment, the boot CD contains a list of selectable configuration files, each corresponding to different video adapters. A second symlink file is created on the RAM, which points to the correct configuration file following a detection of which video adapter is present in the system. The features of this embodiment may be completed independent/exclusive of the features of the XServer embodiment.

The above as well as additional objects, features, and advantages of the present invention will become apparent in the following detailed written description.

BRIEF DESCRIPTION OF THE DRAWINGS

The novel features believed characteristic of the invention are set forth in the appended claims. The invention itself, however, as well as a preferred mode of use, further objectives, and advantages thereof, will best be understood by reference to the following detailed description of an illustrative embodiment when read in conjunction with the accompanying drawings, wherein:

Figure 1A is a block diagram illustrating core components and peripheral devices of a data processing system with which the preferred embodiment of the invention may be implemented;

Figure 1B is a block diagram illustrating sectors of a boot CD with data related to various XServers, configuration files, and boot code with symlink commands all utilized in an illustrative embodiment of the invention;

Figure 2A is a block diagram illustrating the command flow for the server selection as a series of software-based transactions between a boot CD and RAM of data processing system of **Figure 1** in accordance with one embodiment of the invention;

Figure 2B is a block diagram illustrating the command flow for the configuration file selection as a series of software-based transactions between a boot CD and RAM of the data processing system of **Figure 1** in accordance with one embodiment of the invention;

Figure 3 is a flow chart of the process by which a correct XServer is selected from a read only boot CD during implementation of one embodiment of the invention; and

Figure 4 is a flow chart of the process by which a correct video configuration file is selected from a read only boot CD during implementation of one embodiment of the present invention.

FIG. 4 is a flow chart of the process by which a correct video configuration file is selected from a read only boot CD during implementation of one embodiment of the present invention.

DETAILED DESCRIPTION OF AN ILLUSTRATIVE EMBODIMENT

The present invention provides a method, system, and program product by which a boot sequence executing on a read only boot device, such as a CD ROM, is provided with the functionality to enable dynamic selection of both a correct XServer and a correct video configuration file of the specific video adapter/card of the data processing system being booted. As utilized herein, “correct” refers to the particular server and/or configuration file that provides optimal settings for the operation of the video adapter. Usually, the correct server and configuration file are known by the user and may be identified by the system when the video adapter is first installed. Depending on the list of available options, however, “correct” may refer to the most optimal among the available option and not necessarily the most optimal available in the industry for that adapter.

The invention is preferably executed on a data processing system such as the data processing system illustrated in **Figure 1A** and described below. However, the invention finds applicability in most data processing systems including networked data processing systems (with specific server functionality). Particularly, the invention finds applicability in data processing systems operating with a Linux operating system (OS) and the X-Windowing features provided therein. Although, the various aspects and the features provided may be implemented in data processing systems with different OSs.

With reference now to **Figure 1A**, there is illustrated a data processing system in which a preferred embodiment of the invention may be implemented. Data processing system **100** comprises several major components, including CPU **101**, I/O devices **105** and memory **103** (e.g., DIMM). CPU **101**, I/O devices **105**, and memory **103** are interconnected via a system bus **111** (which may be replaced by a switch fabric in other configurations). In order to properly execute related logic functions, memory **103** is

coupled to various other devices via memory controller **102**, which manages operations involving memory access and allocation/deallocation of memory **103**. As illustrated, memory **103** consists of a RAID configuration, known within the art of data processing systems. RAID (Redundant Array of Independent Disks) is a series of hard disks on which data is stored in a redundant manner to improve performance and increase fault tolerance. A RAID system appears to the OS as a single logical hard disk and is controlled by a single adapter and controller.

In addition to the above components, data processing system **100** comprises a video subsystem, which includes video controller **108** and video RAM **106**. Video RAM **106** is memory space utilized to temporarily buffer video images to be displayed. Memory **103** may comprise Read Only Memory (ROM) and Random Access Memory (RAM). RAM is the place in data processing system **100** where the OS, application programs and data in current use are kept so that they can be quickly reached by the system's processor. Also, according to the illustrative embodiment, RAM is utilized to temporarily store at least one secondary symbolic link (symlink) file that points back to the read only CD.

Video controller **108** is coupled to display device **107**, which may be any one of a host of different display devices currently available. Each display device **107** via video controller **108** is capable of displaying graphics with a particular resolution determined by the designer of the device at manufacturing, and the video controller **108** requires particular configuration utilities to be assigned to it by the system during the boot process. Associated with video controller **108** is a video adapter **110**. The video adapter **110** is a collection of software/firmware components, which permit signals generated by the executing applications executing on the CPU to be displayed in viewable format to a user.

Another component illustrated as part of data processing system **100** is Compact Disk Read Only Memory (or CD ROM) drive **109**. CD ROM drive **109** is a peripheral component, which is ideally considered an input device, as it allows data and instructions to be inputted to the processing system. As the name implies, however, the disk media of the CDROM drive (typically referred to as a CD ROM or CD) is read-only and therefore cannot be written to. The features of the invention are particularly applicable to a read only medium utilized as a boot device. However, the features of the invention may be applied to a system having a Read/Write (RW) I/O device and/or a RW medium (for example, a RW CD ROM drive and a disk medium that allows data to be written to the boot device).

Although, the illustrated embodiment depicts only basic components of a data processing system interconnected via a system bus, it is understood that data processing system **100** may be more complex. Data processing system **100** may comprise additional processing systems, with each processing system having additional components (or similar components with a different configuration). Component parts of data processing system may also be interconnected via other methods, such as a switch, for example. Presentation of a particular data processing system configuration is therefore not intended to limit the scope of the invention.

According to the invention, a Linux bootable CD is provided, which makes use of the X-Windows windowing system. Linux OS provides symbolic links (symlink), which points to another file that is executed whenever the symlink is executed.

Figure 1B illustrates sectors of a boot CD ROM with data related to the boot process and selection of video drivers, etc, utilized by the invention. The invention is preferably implemented in a data processing system, which utilizes a CD ROM medium to control its boot process and initialize its various components. Thus, CD ROM sectors

includes sector **151** dedicated to boot code, sector **153** dedicated to OS initialization and configuration set up, sector **155** dedicated to selecting an XServer based on the available video adapter, and sector **157** dedicated to selecting a correct configuration file for video systems. The various sectors contain functional, software-encoded components. The exact configuration of the boot CD is not important to the correct implementation of the invention, so long as the boot CD comprises the relevant boot code (including symlink files) and lists of servers and configuration files utilized to complete the various processes of the invention as described below.

The primary component behind X-Windows is the XServer. The XServer is responsible for displaying the GUI to the user and can also be considered the video driver since it is responsible for drawing the GUI at a certain resolution and color depth specified by the user. As illustrated, the different XServers that each support various video adapters are provided within a sector **155** (or group of sectors) on the bootable CD. Thus, according to the present illustration, the specific XServer may be selected from XF86_VGA16, XF86_SVGA, XF86_FBDev, XF86_S3, XF86_Mach64, etc.

Figures 2A and 2B are block diagrams illustrating specific software commands and or files within boot CD and RAM utilized when selecting correct XServers and correct video configuration files, respectively, according to the invention. The hardware component of interest in the illustrative embodiments is video adapter **210**, which is described in **Figure 1A** above. As shown in **Figure 2A**, CD ROM comprises a symlink file **205** and a series of selectable XServers **201**. Symlink file **205** has a communication link with second symlink file **207** within RAM **203**. Within RAM **203** is a video server memory block that, in one embodiment, is updated with and stores the XServer parameters of the selected XServer from among the group of selectable XServers **201**. In the preferred embodiment, however, the XServer information is maintained on the boot CD and RAM **203** does not store any of the video parameters utilized. Directional

arrows indicate the directional flow of communication (i.e., instructions or data) between boot CD and RAM during implementation of the processes by which the correct video server is selected and activated.

5 When X-Windows starts the boot operation, it searches for the symlink file /etc/X11/X. In the preferred embodiment, this symlink file is modified during creation of the boot CD to "point" to a second symlink file on the RAM rather than directly to a pre-selected XServer on the boot CD. During normal operation, X-Windows loads the server which /etc/X11/X points to, so the invention involves first modifying the object to which the symlink file on the boot CD points so that it indirectly points to the correct XServer. For example, if a user is installing X-Windows on a server which contains a S3 Incorporated S3Trio64V+ video adapter, the user would configure the XF86_S3 Server since this is the server which works with this video adapter. So for example above, the user would require /etc/X11/X to point to /usr/X11R6/bin/XF86_S3 in order to load the XF86_S3 XServer when X-Windows starts.

10
15
20 In order to correctly select this XServer, the invention enables the user to dynamically configure a symlink file on the RAM to point to the desired XServer. However, the dynamic change of the object of the symlink file cannot be completed on the read only boot CD, and thus the invention provides code on the read only CD that creates an image of the symlink file on the RAM. The invention then taps into the functionality of the symlink file enabled by Linux and the write to capabilities of RAM to enable the object (the XServer) to which the symlink points to be changed to dynamically. Thus, the symlink file on the read only boot CD may indirectly support any and every video adapter the boot CD may encounter.

25 To overcome the fact that the boot CD is read only, the invention makes further use of features inherent to a symlink file coupled with the ability to write to an available

RAM drive of the system. Thus, during manufacturing of the boot CD, the /etc/X11/X symlink burned into the CD is set to point to a similar symlink file on a RAM drive. Additional code is provided on the boot CD to automatically create a symlink file on the RAM drive. Code is also provided to enable changing of the object of the created symlink file by a user of the system. Thus, the user may dynamically change the object of the symlink file to point to the correct XServer.

Therefore, as illustrated in **Figure 2A**, /etc/X11/X points to the file /.ram/tmp/X. The /.ram directory is created within RAM when the boot process of the bootable CD commences. The file /.ram/tmp/X is another symlink file, which unlike the original symlink file, may be changed dynamically because it is on the RAM drive, which is a writable medium. Accordingly, /.ram/tmp/X may be set (by the user) to point to the correct XServer that is available on the boot CD. A communication is thus established from the symlink on the boot CD to the symlink on the RAM drive back to the selected XServer on the boot CD. From the above example, the /etc/X11/X file triggers the /.ram/tmp/X file which then points to and selects the /usr/X11R6/bin/XF86_S3 file.

Figure 3 illustrates the process by which the correct server is dynamically selected from among multiple possible servers on a read only bootable medium. The process begins at block 301 and thereafter proceeds to block 303, which illustrates a boot code from a Linux bootable CD being executed. The boot code detects and determines which video adapter is present or affiliated with the system at block 305. Then, the boot code automatically creates a secondary symlink file on the RAM as shown at block 307. The secondary symlink file is dynamically changeable and is utilized to select a specific XServer from among a list of servers provided on the boot CD. Simultaneously with the creation of the secondary symlink file, the object of the secondary symlink file is set to point to a specific XServer from among the list of XServers provided on the boot CD. The specific XServer corresponds to the XServer required for the adapter to operate

correctly. An X-Window application/process is initiated to find the correct XServer as shown at block 309. To complete this process, the symlink file on the boot CD is executed, points to and triggers the secondary symlink file created in RAM as shown at block 311. The secondary symlink file is then executed and points to and selects the specific XServer from the boot CD as shown at block 313. This activates the specific XServer file to provide XServer support for the video adapter while the system is operating as shown at block 315. Then the process ends as indicated at block 317.

In another embodiment, the features of the invention are extended to also select the configuration (config) file required by the video system based on the XServer selected. To configure the XServer, the file /etc/X11/XF86Config file is modified. The configuration file is used to describe the video hardware to the XServer and to set the parameters desired by the user such as video resolution and color depth. When the XServer starts, it looks for this configuration file on the boot CD and reads the configuration information stored within. XServer specific information is stored within the XF86Config file and utilized by the XServer, so it is important that the XF86Config file contain the correct information for the particular XServer that is being used.

Also, because the same XF86Config file cannot be used by every XServer, it is necessary that the XF86Config be changed based on the XServer being used. As with the situation involving the symlink file described above, the boot CD-ROM is read-only and only one pre-selected XF86Config file is operational during the initial boot. Similar to the above example, the invention modifies the /etc/X11/XF86Config file to create a configuration symlink which points to the RAM drive. A corresponding /etc/X11/XF86Config file is created on the RAM drive with a selectable object. The object of the second /etc/X11/XF86Config file is dynamically changed to point to the correct XF86Config file available on the boot CD. Thus, like the XServer example, and as illustrated in **Figure 2B**, communication is established between the boot CD and

RAM and the configuration symlink files are utilized to initiate selection of the correct configuration file. Communication is established from /etc/X11/XF86Config to /.ram/tmp/XF86Config and then to /etc/X11/XF86Config.S3, where .S3 represents the object that was dynamically selected for the configuration symlink on RAM.

Figure 2B illustrates a similar software communication model between boot CD and RAM as **Figure 2A**. Similar components share the same reference numerals and are described with **Figure 2A**. However, in **Figure 2B** a series of selectable configuration files **221** replaces the XServer list of **Figure 2A**. Also, configuration symlink file **3 225** initiates configuration symlink file **4 227** and RAM **203** comprises a memory block **231** which holds the data/information of the selected configuration file. As shown in **Figure 1B**, both the list of servers and the list of configuration files may be provided on a single boot CD, although the invention contemplates that either list and the functional features by which an item is selected from either list and activated may be selected/activated exclusively and independently of the other. Using the functional features of the invention, the XF86Config file is changed dynamically at boot time based on the video adapter and XServer being used.

Figure 4 illustrates the process by which the correct video configuration file is dynamically selected from among multiple possible configuration files on a read only boot medium. The process flow of **Figure 4** is similar to that of **Figure 3**; however, as stated above, the process involves selection of the correct configuration file and not of the correct XServer. Thus, the process begins at block **401** and thereafter proceeds to block **403**, which illustrates a boot code from a Linux bootable CD being executed. The correct XServer is then identified and a configuration file selection routine for that XServer initiated as shown at block **405**. Identification of the XServer may be completed according to the process described above in **Figure 3** or any other process. In one embodiment, the process includes a step at which the boot code determines which video

adapter and XServer is present or affiliated with the system. The boot code automatically creates a secondary configuration symlink file on the RAM as shown at block 407. The secondary configuration symlink file is dynamically changeable and is utilized to select a specific configuration file from among a list of configuration files provided on the boot CD. Following the identification of the correct adapter and XServer and the copying of the secondary configuration symlink file to RAM, the object of the secondary configuration symlink file is set to point to a specific configuration file from among the list of configuration files provided on the boot CD, as depicted at block 409. The specific configuration file corresponds to the configuration file required for the XServer and video adapter to operate correctly. Following, the boot code executes to a configuration symlink file to find the correct configuration file as indicated at block 411. The configuration symlink file on the boot CD is executed and points to and initiates the secondary configuration symlink file created in RAM as shown at block 413. The secondary configuration symlink file points to and selects the correct configuration file from the boot CD as shown at block 415. This activates the configuration file to provide configuration support for the XServer and video adapter while the system is operating as shown at block 417. Then the process ends as indicated at block 419.

Several functional obstacles are overcome by the invention including: (1) enabling the /etc/X11/X symlink on a read only medium to point to a selectable XServer. Previously the symlink could only point to one XServer and if this XServer did not work for the video adapter present, then the boot process would fail, and (2) enabling dynamic user selection from a read-only medium (CD-ROM). Enabling the read only bootable CD to support a wide range of hardware configurations found on the servers. This further allows the read only boot CD to maintain compatibility with every server in the Netfinity portfolio.

It is also noted above that the invention may be completed on systems that are not booted with a read only medium. This may be desired for all Linux boot operations from any medium because the creator of the boot medium will not know if the medium can be written to since the CD ROM drive may or may not support write operations, irrespective of whether the medium is read only or read/write capable. Also, even if a default server is utilized, (i.e., no dynamic server selection is enabled) the dynamic, configuration file selection process may still be completed and vice versa.

As a final matter, it is important that while an illustrative embodiment of the present invention has been, and will continue to be, described in the context of a fully functional data processing system, those skilled in the art will appreciate that the software aspects of an illustrative embodiment of the present invention are capable of being distributed as a program product in a variety of forms, and that an illustrative embodiment of the present invention applies equally regardless of the particular type of signal bearing medium used to actually carry out the distribution. Examples of signal bearing media include recordable media such as floppy disks, hard disk drives, CD-ROMs, and transmission media such as digital and analog communication links.

Although the invention has been described with reference to specific embodiments, this description should not be construed in a limiting sense. Various modifications of the disclosed embodiments, as well as alternative embodiments of the invention, will become apparent to persons skilled in the art upon reference to the description of the invention. It is therefore contemplated that such modifications can be made without departing from the spirit or scope of the present invention as defined in the appended claims.